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EP A2 0008567
WO 8001581
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(54) Hospital construction transportable by water

(57) The hospital construction can be floated from its construction site to the site where it is to be used.

The hospital construction comprise a load-bearing structure including a double hull (3, 4) and a double bottom (5, 6) forming a rigid water-tight space, acting as a barge during transport and as a foundation when installed at its destination, the load-bearing structure also including a deck comprising a grid of longitudinal and transverse beams, lines of pillars (17) supported on the intersections of said beams from the double bottom, and a freeboard deck (13), said load-bearing structure supporting a superstructure equipped with technical material and installations.

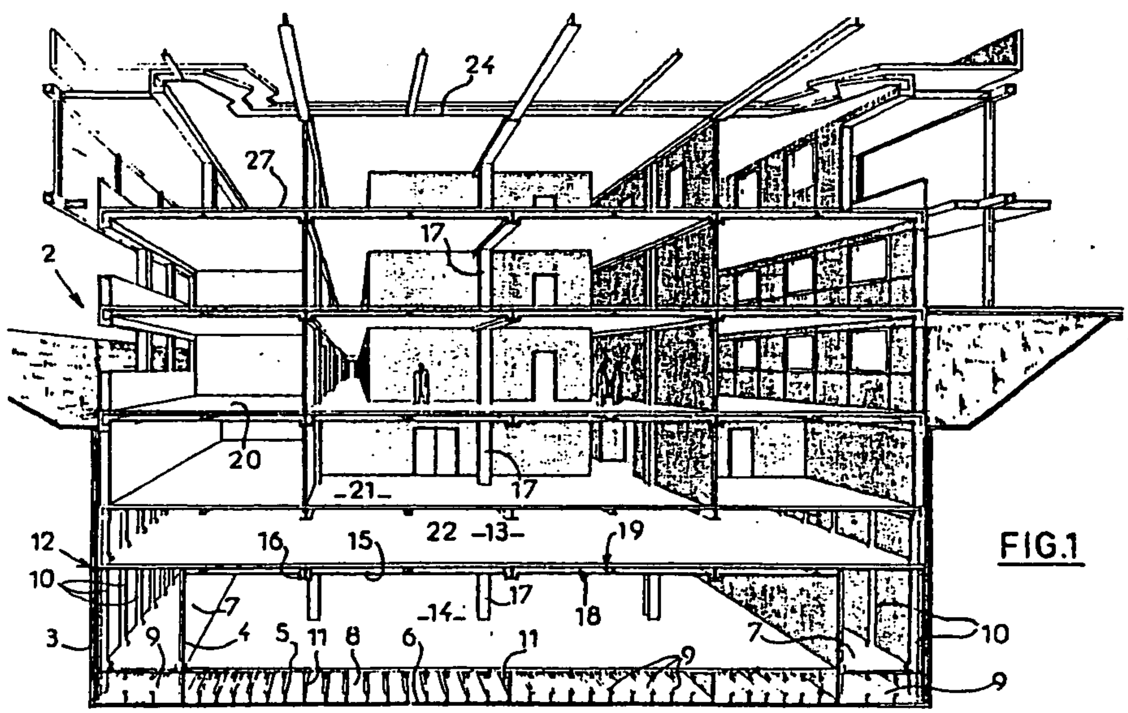

FIG.1

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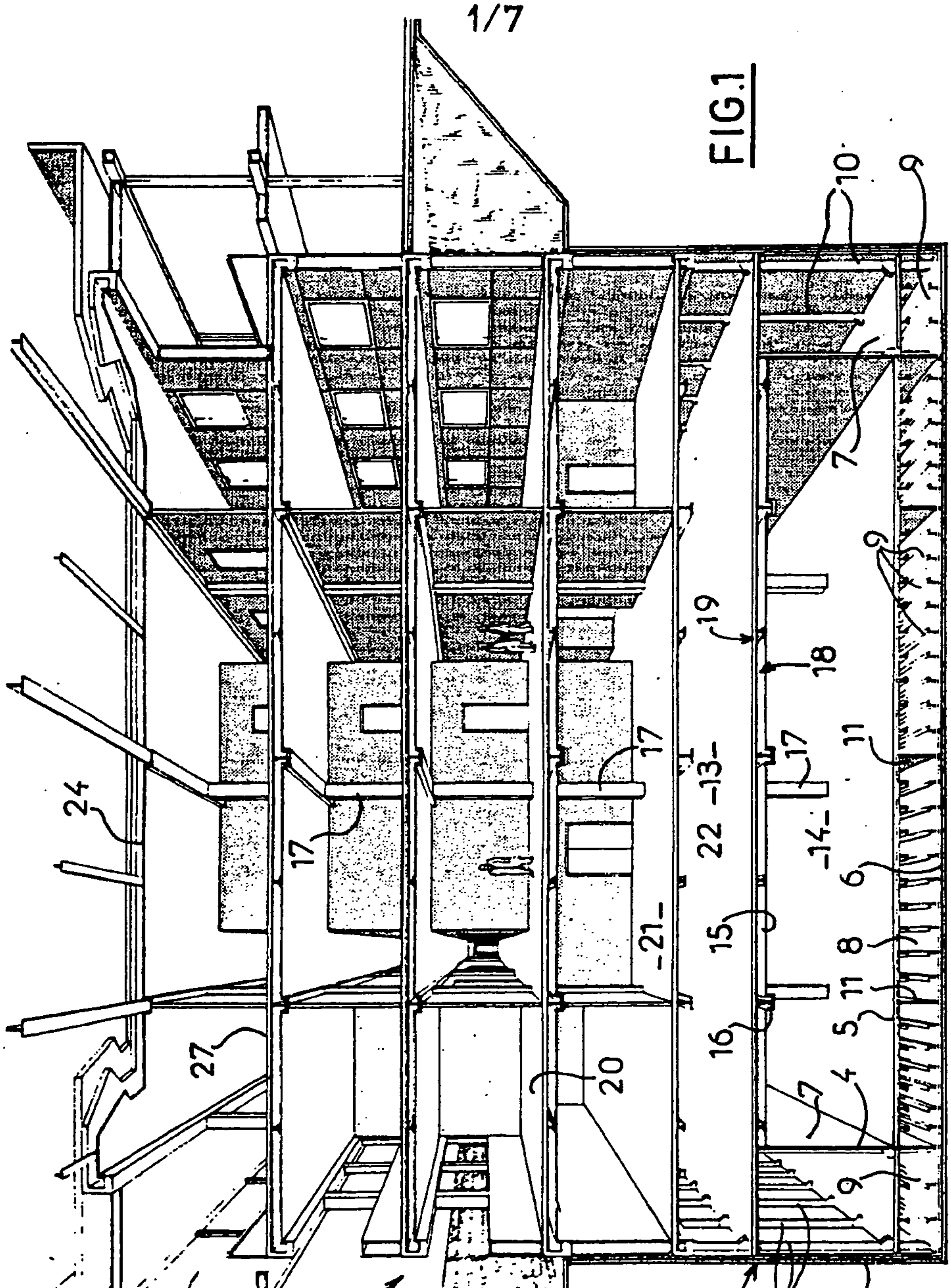


FIG.1

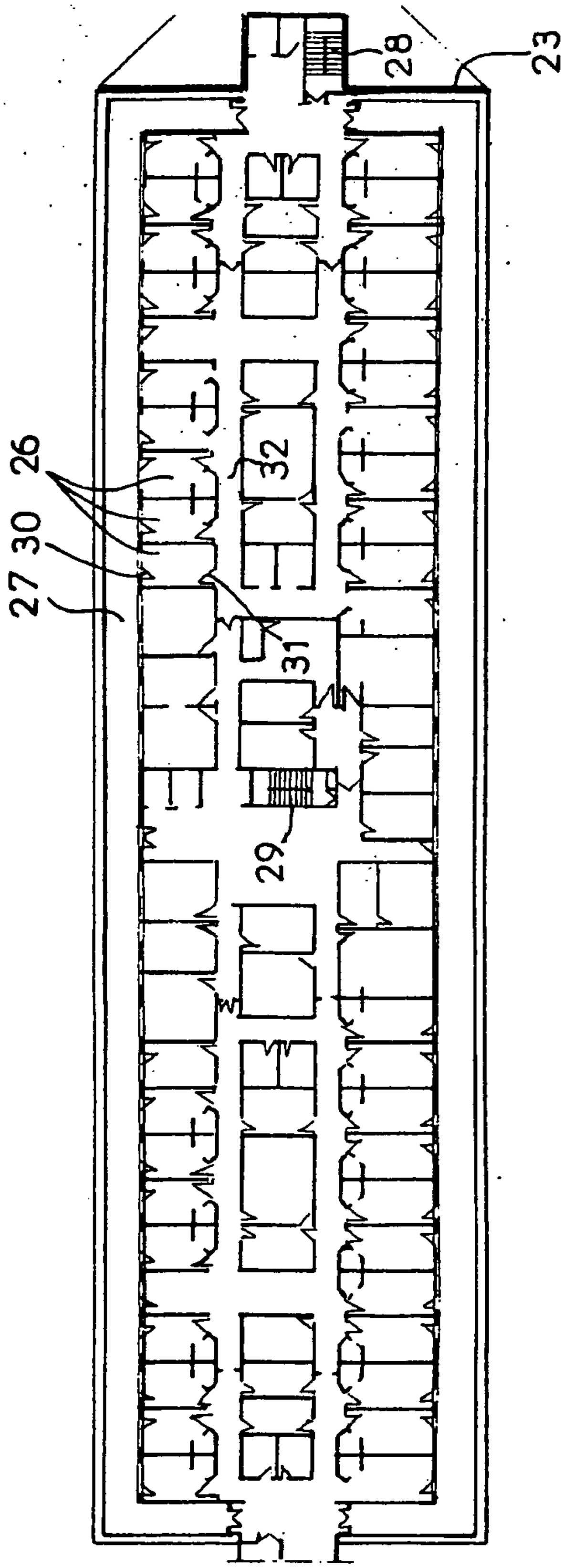
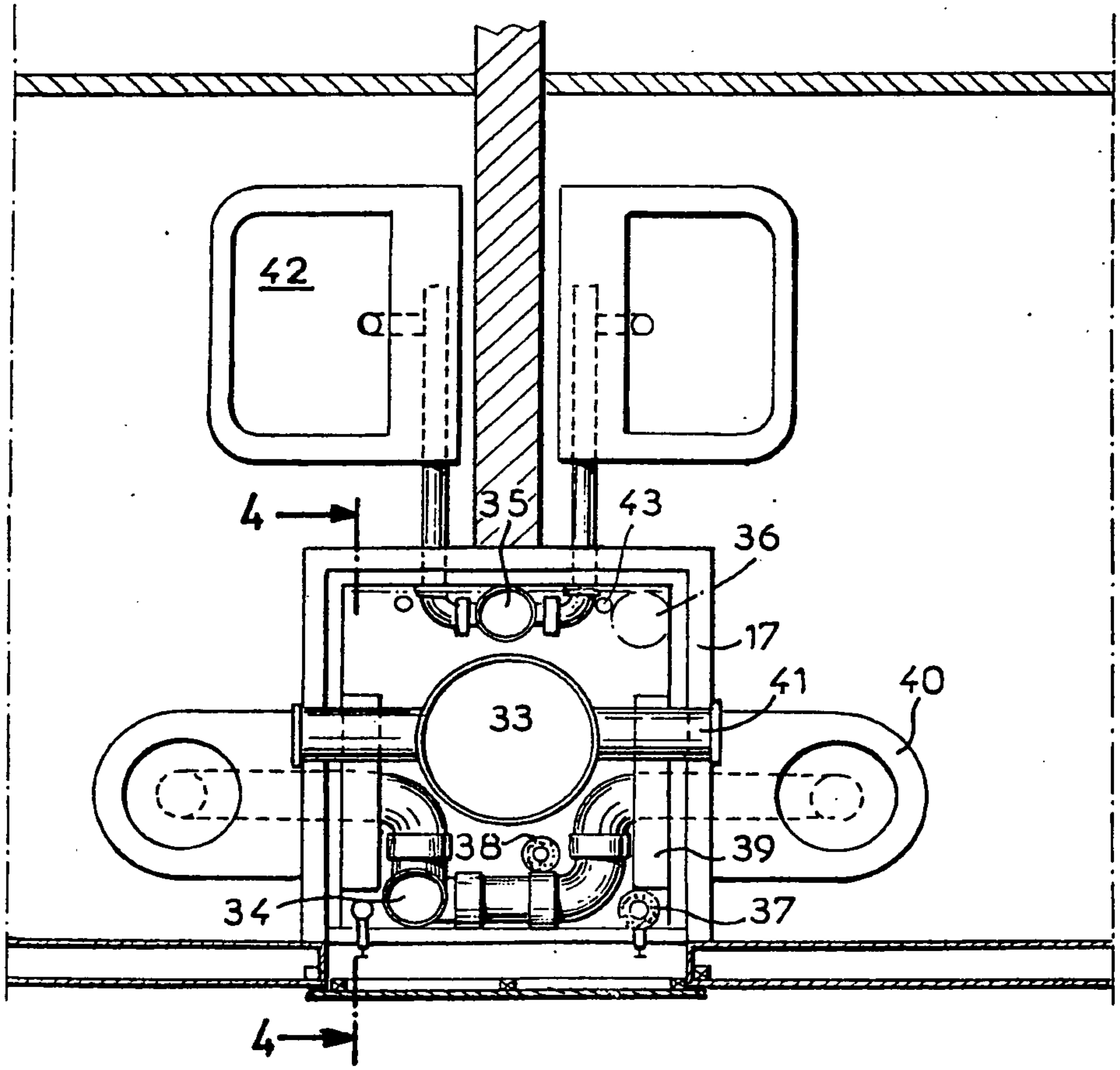


FIG.2

FIG.3



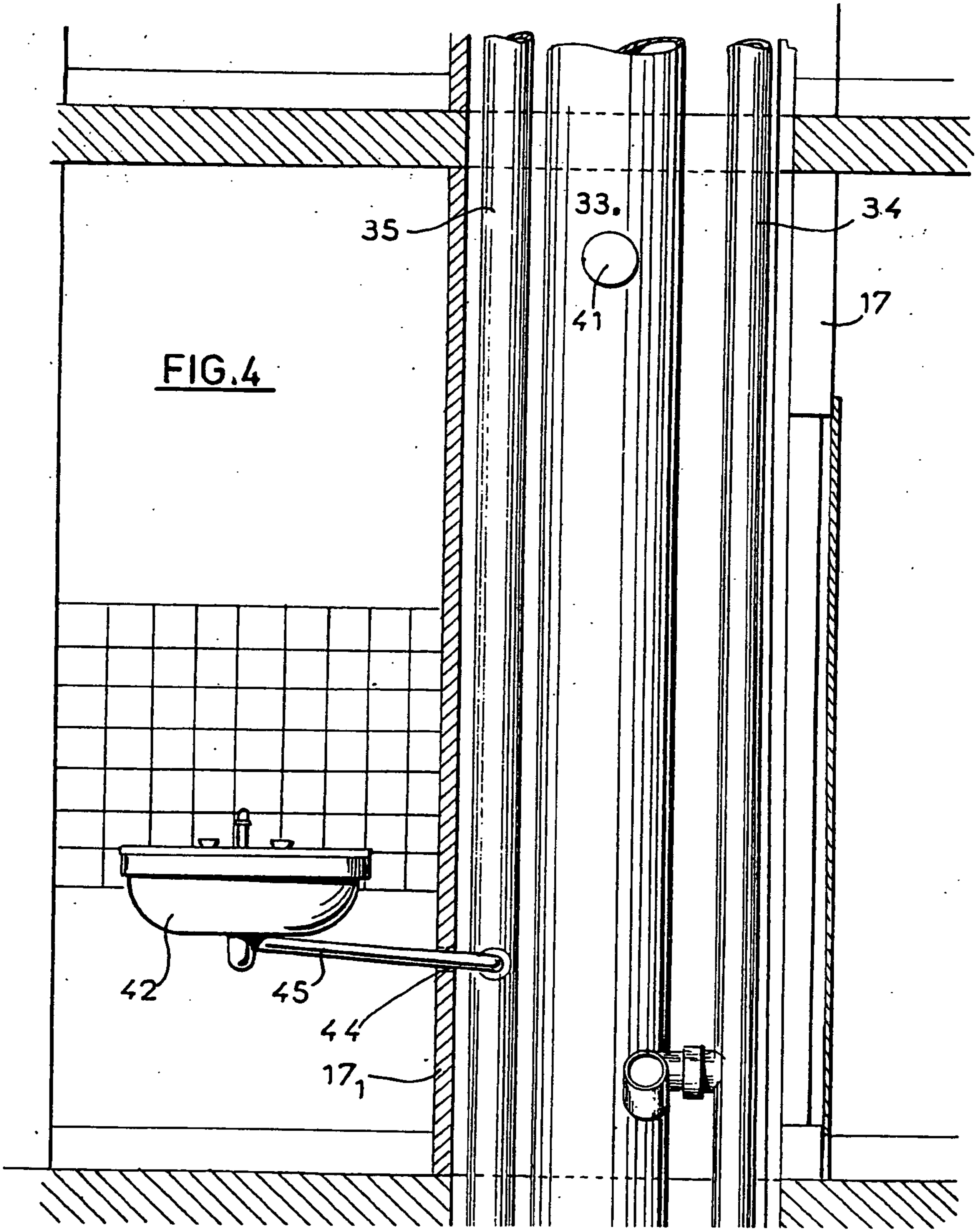


FIG.4

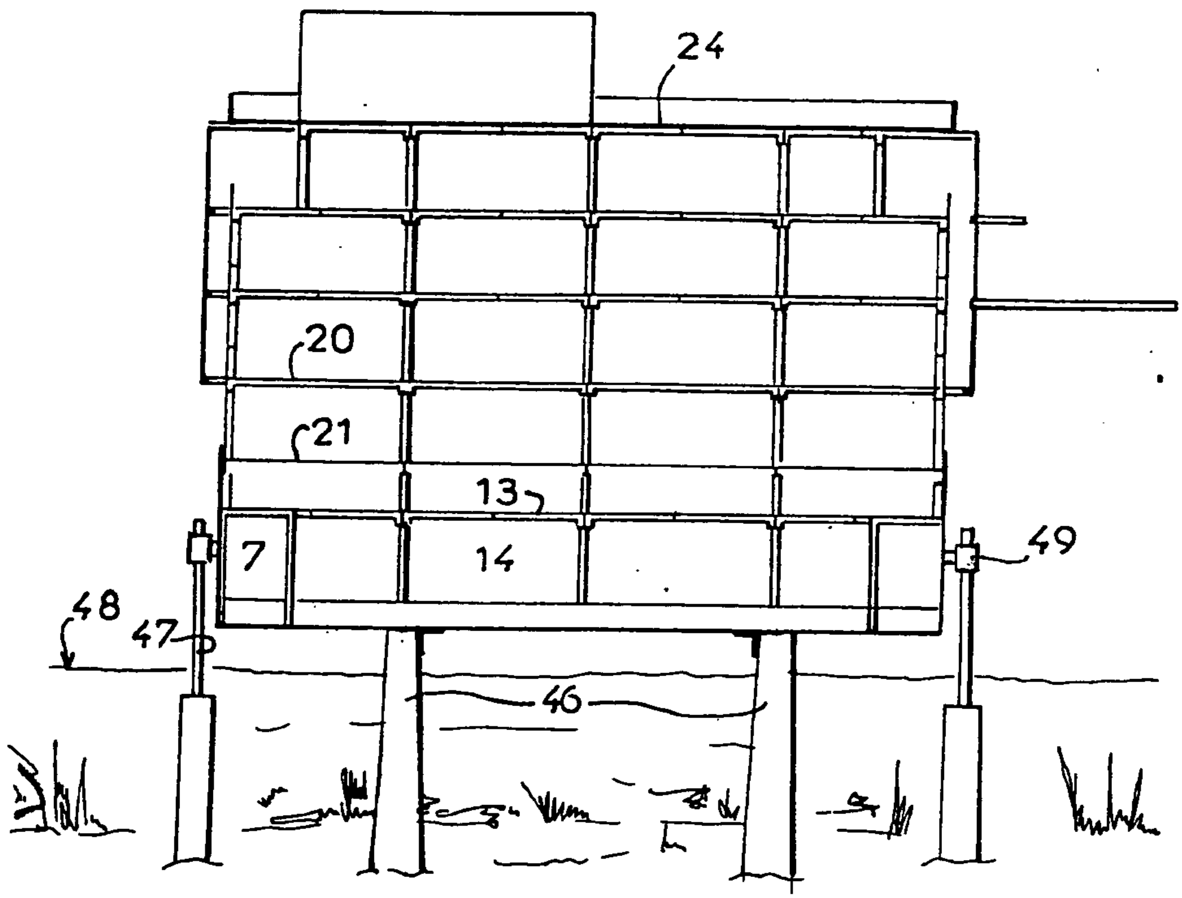


FIG.5

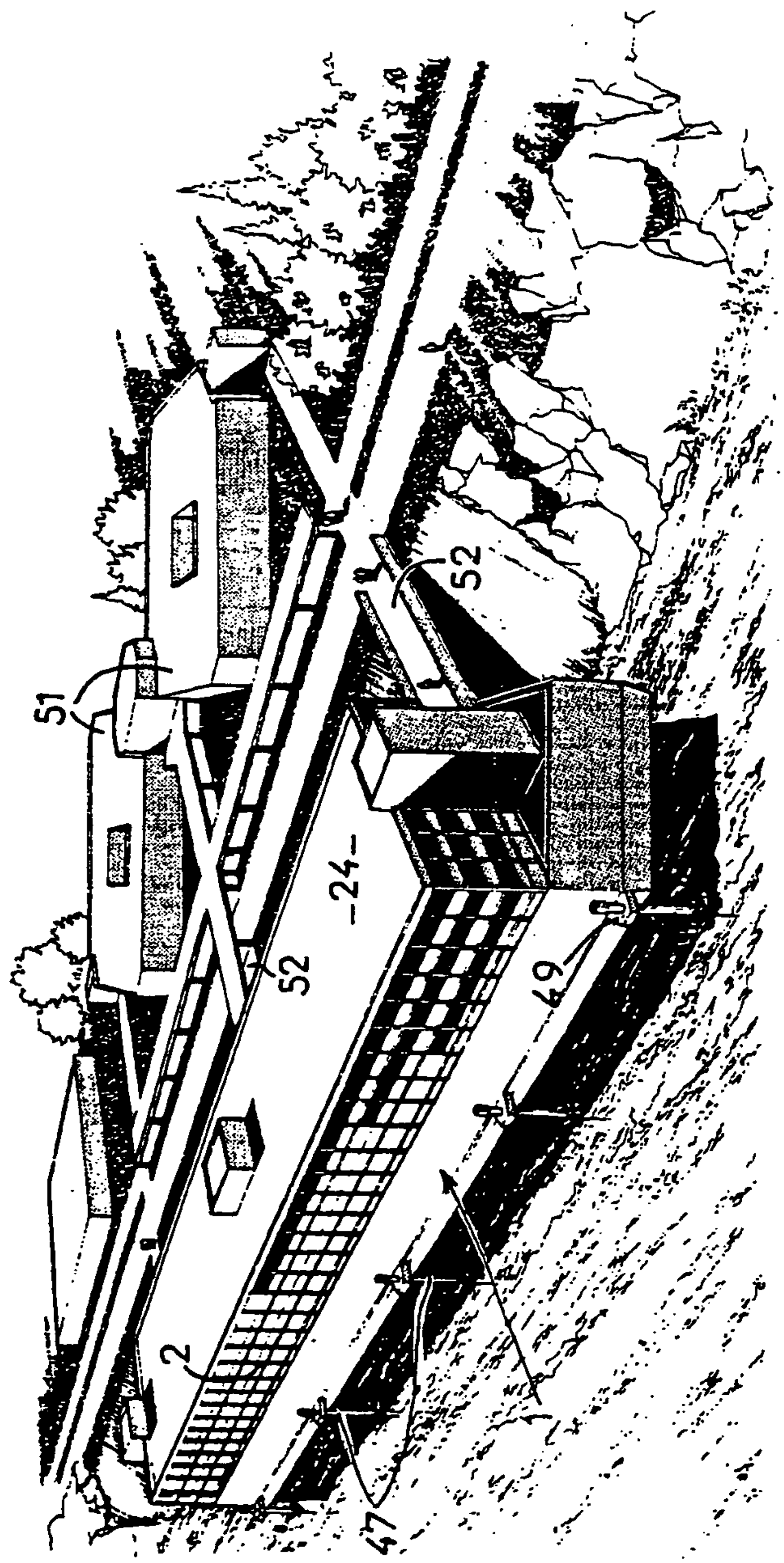


FIG.6

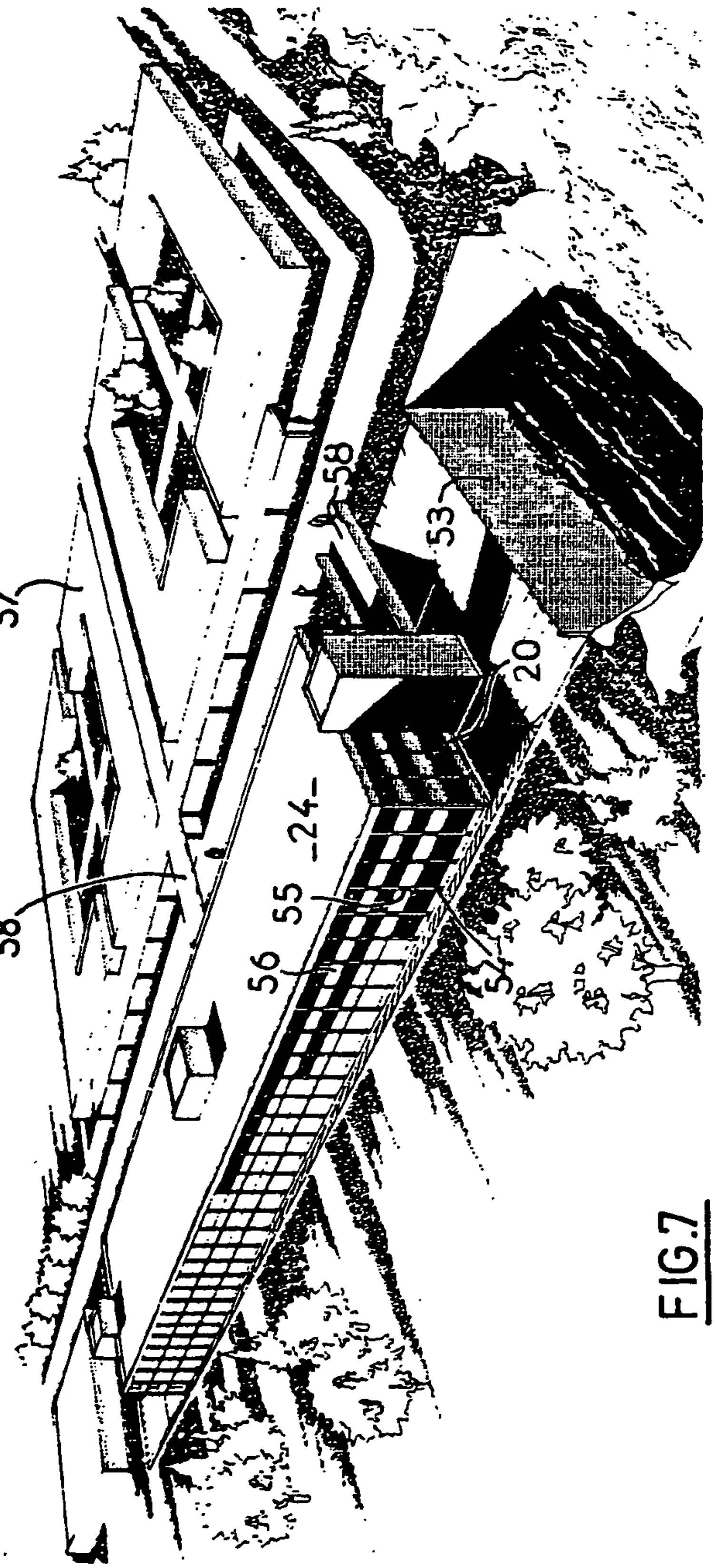


FIG.7

SPECIFICATION

Hospital construction transportable by water

The invention relates to a construction which is transportable by water, either by sea or by inland waterways, and more particularly to a hospital construction which can be floated, towed for example, from a construction site to a usage site and can either be fixed permanently at its destination or transplanted on to other usage sites, especially in regions deprived of hospitals.

Constructing a hospital complex on site by conventional techniques, especially in less industrially and technically developed countries, that is to say lacking the technological and scientific resources required for creating such a sophisticated establishment as a hospital, can only be considered under the conditions that all material and equipment required in the construction are brought in to the site and skilled staff needed are brought from industrialised countries, or from centres which are often very remote from the installation site for the hospital establishment. These movements of material, equipment and personnel obviously lead to very high construction costs so that the country (which often is a developing country) to whom this kind of establishment is offered pays the cost of a substantial added value which is due in fact to the weakness of its own resources. This is therefore a formula which, from humanitarian, social and economic points of view, is not worthwhile since it makes the least rich countries a bit poorer still.

To solve this problem, at the scale of the whole world, it is proposed to use the technique of "floating factories", adopting the principle of a construction which can be towed, but adapting it to the particular case of a hospital. Indeed, since 1980, floating factories have become important business since, out of 150 projects planned at the end of 1980, 43 have been carried out so far. The term "floating factory" is used to refer to a factory built on a ship or a barge (in steel or in concrete) and which is floated away from its construction site. These factories usually fall into three categories of technico-economic requirements:

— impossibility or great difficulty in construction by conventional techniques, due to eliminate conditions or lack of technical environment (Alaska or Siberia for example);

— exploitation of the resources of the ocean (degassing petrol, off-shore oil fields, canning industries);

— emergency requirements (energy, water, concrete) or lodging requirements during the installation of an industrial complex or town centre, requirements often found in developing countries.

These two factors (high cost and difficulty of producing remote hospitals, and availability of floating factory technology) lead to consideration of construction of a hospital establishment on a floating structure.

The construction of a complete hospital is not normally preferred; only the technical units (generation of energy, heating or refrigeration) and medico-technical services are normally incorporated in the floating structure, which corresponds to the facilities requiring the most skilled labour and incorporating the most sophisticated material and equipment. With these technical services are included 60 beds designated as "hot", that is to say intended for patients needing the most nursing, that is to say continuous and intensive care. For this reason, the design and organisation of these bedrooms will depend more on technical or medico-technical necessities than on considerations relating the ways of life or habits. It follows that their appearance and the design of the installations will be very close to what is currently produced in the conventional hospitals of the western world.

However the hospital construction on a floating structure can be connected up on arrival on site to lodging units built independently of the floating structure, which can have a technical design and architecture which take account of the habits and customs of the local population. Equally, the lodging unit can include extra beds and certain common general services, this permanent construction enabling local firms to share in the construction work. The hospital floating structure may, on arriving at the site of use, be installed by two distinct methods:—

a) placing the barge on piles to avoid it being subjected to the movement of the swell, the barge being connected to land by a gangway offering access to medium weight vehicles, or by a causeway (this solution enables subsequent transplantation of the hospital unit).

b) Creation of a bed or foundation point, on which the barge will be grounded and stabilised. In this case, communication with the sea or waterway will then be cut off by partially filling in up to two levels. This installation will be connected to land based networks (electricity, water, sewage, gas, telephone, for example) by a service bridge, as described below.

The invention relates to producing at a first land based site a hospital or part of a hospital, whose structure presents the characteristics of enabling the construction to be launched and floated, with the marine qualities enabling it to be transported by water (sea or inland waterway) to another site. The hospital may be fully equipped and installed so that it will be immediately operational and autonomous. However, as mentioned above, its main vocation is for insertion in a prebuilt or subsequently built complex. It therefore contains, to this end, the main technical equipment, including generation of energy and treatment of fluids, as well as the medico-technical services of a general hospital.

The invention therefore provides more particularly a hospital construction for floating by water to its site of use and standing on the ground once at its site of use, comprising a superstructure and a load-bearing structure bearing said superstructure, said load-bearing structure comprising a double walled hull and a double

bottom, the spaces within the hull and bottom being sealed and rigid, the load-bearing structure providing a float when the construction is launched into water and a foundation when the construction stands on the ground, said load-bearing structure comprising longitudinal and transverse beams intersecting orthogonally to form a grid, lines of pillars supported on the intersections of said beams from said double bottom and a free board deck supported on said beams, said superstructure comprising at least one storey equipped with technical installations and material for use in operation of the hospital.

In a preferred embodiment of the invention said load-bearing structure forms a barge of generally U-shaped transverse section, whereby to define with said freeboard deck a space for technical services.

In an embodiment of the invention said load-bearing structure forms a unitary float, said hull and said bottom comprising sheet metal modules of dimensions corresponding to said beams and welded edge to edge, and reinforced by longitudinal and transverse stiffeners, said hull extending above said freeboard deck.

Advantageously said beams comprise transverse members and longitudinal carling forming a grid supported on said pillars, said freeboard deck and the floors and decks above comprising a metal floor covered by a layer of reinforced concrete.

The invention also relates to a method of producing a hospital comprising producing a hospital construction as described above at a first site, launching the construction onto water with said load-bearing structure floating to support said superstructure, transporting said construction by water to a second site, and installing said construction on ground at said second site.

Other features and advantages of the invention will appear from the following description and the accompanying drawings, given by way of example, in the drawings:—

— Figure 1 is a sectional perspective view taken from a transverse plane of a construction in accordance with the invention.

— Figure 2 is a plan view of one of the storeys of the construction and, more particularly, the storey which is visible when a terrass is cut away.

— Figure 3 is a transverse sectional view of one of the deck props, showing the passage and branching of the service channels.

— Figure 4 is a vertical sectional view taken along the line A—A of Figure 3.

— Figure 5 is a diagrammatic front view of the construction in position on piles.

— Figure 6 is a perspective view of the construction on piles in its final position connected to fixed units.

— Figure 7 is a perspective view of a grounded construction, connected with a land based complex.

The basic principle of the invention resides in the construction on a land based site of a hospital, or of a part of a hospital, whose structure is designed to enable it to be launched on water with sufficient marine qualities to enable it to be transported floating on sea or inland waterways to another site. The hospital may be fully equipped and installed so that it is immediately operational and autonomous. However, its preferred vocation is to be inserted as part of a structure, the rest of which is previously or subsequently built on site. To this latter end, the construction transported contains the essential technical equipment, including generation of energy and treatment of fluids, as well as the medico-technical services of a conventional hospital.

The design of the construction is intended to ensure a high level of safety, both in the transport situation when the construction is being moved or towed, and in the final situation on site.

The design of the floating construction meets the requirements of classification organisations such as BUREAU VERITAS, and the design also meets the standards imposed for the safety of building constructions to which the public have access when the construction is landed.

The integration into a hospital establishment starting from a floating structure, comprises two distinct phases:

— the design and construction of a floating structure which is to be towed,

— construction work on site, which may be performed in conventional ways and which involve preparing the area which will receive the floating structure (ground bed or pile foundations) and constructions to be built on land (additional lodging units, common services, technical and road access infrastructures).

A common design analysis is applied to the detailed medical and technical establishment plan. Starting from these plans, the definition of what it is necessary to include in the floating structure is decided. As a function of that decision, the design work follows two parallel but distinct routes:

— preparation of the site for receiving the floating structure and performing the construction work on land, using conventional techniques,

— producing the structure itself, dividing up the space, so as to create the services required by the plan (technical equipment, furniture) installing prime support facilities, towing at sea or on inland waterways, and grounding or positioning on piles, all of which operations, apart from the last ones, being performed in a dockyard.

The third phase of the work involves finishing so as to harmonise the complex, that is to say providing connections from the floated structure to external networks and roads, packing in round the structure if required, and protecting and detail finish.

The construction, being in fact a hospital establishment, comprises (Figure 1) two main parts, the load bearing float or floating structure 1, and the building part itself 2 which is supported by the float 1.

The load bearing structure comprises a double hull and a double bottom formed respectively by metal walls 3, 4 and a double bottom formed

respectively by metal walls 3, 4 and 5, 6, the spaces between these walls being compartmented to form side caissons 7 and bottom caissons 8 which are stiffened inside by sections or stiffeners of which some 9 extend longitudinally while others 10 extend transversely. Those stiffeners ensure the rigidity of the floating structure and avoid its distortion during transport. Strength is important, since the floating structure must have all marine qualities marine qualities necessary to support the variable forces of swell.

In addition, the metal structure not only has high resistance to distortion and twisting when floating, but also has the advantage of resisting earthquakes when it is implanted on ground at the usage site.

The load bearing structure or barge is constructed basically in a longitudinal system, and the double bottom comprises keelsons, one (11) of which is central, and beams spaced apart every five ribs in principle. The structure is constructed in a system of standardised elements approximately 7,20 m long, each sheet metal element forming the hull of the barge being of modular design and being edged by deck props or deck prop partitions described below.

Two main transverse partitions complete the strengthening of the structure and form braces against transverse loadings during towing and after the towing phase, since they provide bracing of the construction after installation and form part of the fire protection compartmenting.

The caissons 7 and 8 forming the sides and bottom of the barge are sealed to form spaces which enable ballasting of the barge during towing and provide floating capacity if the barge is damaged on the side or the bottom. The same caissons will also serve for adjusting the immersion level of the construction to optimise the navigating characteristics of the vessel, or to lighten the construction for grounding or positioning on piles. When the construction is installed on site at its destination, these caissons are also put to other uses, and can serve as reservoirs for fuel used in generating energy, heating or refrigerating or as reservoirs for drinking water if the connections to the land based network present risks of interruptions in supply, or as reservoirs for fire-fighting water, or as various stores.

This barge of metallic construction, is entirely joined by welding, and formed from plane areas of rectangular transverse section, and the barge consists of a cylindrical part having a length of 112,8 m; the width of the double hull is 24,00 m and it extends from the double bottom up to the level of the freeboard deck.

The barge has a transverse section of U-shape and its central part defines with the freeboard deck 13 a space 14 which is useful for installing the main services and machines relating to the hospital (heating, air conditioning, generation of various gases, emergency electricity generator, stores and various reservoirs such as fuel and water).

The freeboard deck 13 is formed from a metallic grid 14 formed from deckbeams 15 extending transversely and connected with carlings 16, extending longitudinally, the intersections of these sections being supported on deckprops (posts) 17 which bear the vertical loads. This load bearing skeleton of the freeboard deck is covered by a metal floor 18 on which can be placed a floating layer of reinforced concrete 19, whose function is to level out the irregularities due to the construction technique, and also providing sound insulating and fire proofing for the construction. Under the under surface of the freeboard deck is positioned a dummy ceiling for acoustic and thermal insulation. The deck props 17 are disposed at the intersections of the links in the construction so as to support the vertical loads, as mentioned previously. Between the freeboard deck 13 and the upper deck 20 is provided an intermediate deck 21 which defines, with the freeboard deck 13, a service space 22 which serves for the passage of the different ducting circuits for their distribution to the spaces above. This service space will also be used for movements and for different service operations during towing.

The barge also comprises, at each side of its front end, reinforced walls 23 (Figure 2) providing sealing and resistance to distortion for the structure during the towing phase.

From level 2 up, that is to say from the level of the intermediate deck, the construction is generally similar to an ordinary land based building. The design, distribution and installation of the different spaces respect the rules for land based buildings of the same category. They benefit however from certain arrangements inherent in ship building. These constructions respect the standards of safety of buildings to which the public have access particularly as far as fire prevention and fire fighting, and the risks of panic are concerned. The design of the load-bearing structure, which is suitable for supporting the movements of seal swell, makes it meet right from the start the rules for earthquake-proof buildings, since the load-bearing structure is constructed so as to resist repetitive moving distortional stresses.

Each deck is constructed in a similar way to the freeboard deck, that is to say with a metal skeleton formed from orthogonal deck beams and carlings covered with a metal floor and a layer of reinforced concrete. The medico-technical rooms, and the bedrooms are distributed so as to enable easy access by visitors and by the nursing staff, as may be seen from Figure 2 where a bedroom storey is shown disposed beneath a terrace 24 (Figures 1 and 5); the terrace can be covered with material for storing solar energy or with solar cells. The lodging storey is formed by bedrooms 26 spaced mostly round the edge of the edifice in a loop arrangement, the remaining central part being occupied by the medico-technical blocks, treatment rooms, the stations of the nursing staff, the linenroom, the supervising offices, sanitary

facilities and so on. The bedrooms are surrounded by a corridor 27 forming a peripheral alley-way which can be in the form of a balcony or which may on the contrary be closed when the construction is to be installed in very hot or very cold climates. This alley-way serves for the movement of visitors who can gain access to it by lateral stairs 28 or central stairs 29, stairs or lifts 28 being situated inside the alleyway wall 23.

Each bedroom 26 comprises an access door 30 for visitors opening into the alleyway and a second door 31 facing the first one and opening into the corridor 32 running along the medico-technical blocks. This arrangement gives a satisfactory work organisation and avoids the hospital staff being hindered or disturbed during nursing by the visitors.

According to a feature of this embodiment of the invention, as shown in Figures 3 and 4, the deck props or pillars are formed by tubular posts which not only support vertical loadings but also provide service channels for piping for fluids. Thus, the pillar 17 shown in Figure 3 has an air extraction duct 33, a drain pipe 36 for rain water, a hot water riser 37, a return pipe 38 for hot water, a cold water riser (not shown), a hidden tank of water 39 for a lavatory pan 40, an extraction opening 41, an external wash basin 42, a vacuum duct 43; similarly this arrangement can be used to form ducting for electricity supplies, telephones and so on.

These pillars present side openings enabling the services to be presented at each storey from the service ducts that they enclose. The openings are shown at 44 in Figure 4, where it will be seen that the wall 17_1 of the pillar has the duct 45 going to the wash basin 42 passing through. This system thus hides and protects all the service ducts while facilitating their distribution.

When the construction is finished it is towed to the site where it will be put into use by sea or inland waterway and is then installed in the form of "standing piles" or "grounded" according as the construction is fixed permanently in place or is to be transplanted again to another site.

The possibility was excluded right from the start of simply mooring the still floating construction and connecting it to the ground by gangways whose design would accommodate variations in water level. The two most appropriate solutions in the case of a hospital appear in fact to be fixing on piles or on the ground. In the position "standing on piles" (Figure 5), the piles 46 are driven into the bottom, and then fitted with reinforced concrete pillars comprising metal brackets welded under the hull, or with metal pillars. The floating construction is then placed between these pillars, and, by a system (fixed or movable) or jacks 47 (mechanical, hydraulic or pneumatic) is hoisted to a level above the water 48 so that the construction is away from the swell. The system of jacks, the "jack-up", is distributed (Figure 6) around the periphery of the hull, which becomes the foundation of the construction, and cooperates with brackets 49 welded on the facade of the barge. It is also possible to place the hospital on piles using a submersible barge usable for other operations of the same kind. In this type of installation the construction out of the water (Figure 6) is connected to the lodging unit 51, which is prefabricated on the spot, by gangways which accept medium weight vehicles, or by a causeway. This arrangement, as mentioned above, enables the unit to be displaced subsequently by simply disconnecting the piles and immersing the hull partially, using the ballast capacity of the double bottom and the double hull of the load bearing structure.

In the "grounded" construction (Figure 7), the construction is placed on piles 46 or temporary lands forming foundations; the system is prepared in a bed made in the bank of the shore; the connection between the construction and the foundations may be achieved by welding. The bed is then drained by pumping and filled in. The filling level depends on the overall topography of the project; it can reach the level of the upper deck 20, in which case it leaves the top three storeys 54, 55, 56 exposed above ground.

In this case also, the construction is associated with buildings 57, which may be lodgings built before or after the hospital arrives, access being by footbridges 58. The load-bearing structure or hull again may comprise connections for joining service ducts, and particularly drainage and waste water as well as drinking water and electricity supplies to the networks provided on the site.

The "standing on piles" solution is mainly used when the nature of the shore presents too many difficulties for the construction to be grounded, for example if there are compact rocks, tides which are too big, or unstable ground. Moreover, this solution is useful if the plan is to displace the construction subsequently.

The construction described above presents many advantages, for example:—

— the constructions are often to be exported and especially exported to developing countries, especially in regions where the climate or the lack of technical support create difficulties or even make conventional solutions impossible.

— the fact that the most sophisticated part of the construction is made by industrial techniques, to provide a hospital complex which will leave its initial construction site finished with full equipment and furniture, fully tested, constitutes a very significant advantage compared to conventional construction.

— to produce a construction with equipment like that offered, 75% of the material and supplies would have to be imported to the ultimate destination. The consolidation of the material and supplies, their packaging, despatch, transport, unloading, customs clearance, transfer and site storage would present many problems if performed separately.

— as for labour, almost 70% would be consumed by expatriate personnel, with consequent expenses, reduced performance, and

delays due to supply interruptions or deliveries which are out of specification.

— when it arrives on site, the construction contains the most technical and sophisticated elements and equipment, in the form of a vast functional container.

In its basic form, the hospital complex fullfill the requirements of 250 to 300 beds. Given that the "critical" beds are contained in the construction (50 to 60 approximately the local construction firms of the destination country can make the less specialised lodgings.

In addition to these works, are to be added shops, offices, road infrastructure, supply networks, site preparation. The local firms therefore have the possibility to contribute to the production of their facilities and make them according to local design. Apart from technical questions, this is a fact in ensuring favourable reception of the project.

Lastly, the construction can advantageously comprise on the terrace 24, a covering enabling solar energy to be stored, or conventional solar energy transducers to be positioned so as to recover solar energy and transform it into thermal or electrical energy. This feature is particularly advantageous when the hospital complex is installed in sunny climates.

CLAIMS

1. A hospital construction for floating by water to its site of use and standing on the ground once at its site of use, comprising a superstructure and a load-bearing structure bearing said superstructure, said load-bearing structure comprising a double walled hull and a double bottom the spaces within the hull and bottom being sealed and rigid, the load-bearing structure providing a float when the construction is launched into water and a foundation when the construction stands on the ground, said load-bearing structure comprising longitudinal and transverse beams intersecting orthogonally to form a grid, lines of pillars supported on the intersections of said beams from said double bottom, and a free board deck supported on said beams, said superstructure comprising at least one storey equipped with technical installations and material for use in operation of the hospital.

2. A hospital construction as claimed in claim 1 wherein said load-bearing structure forms a barge of generally U-shaped transverse section, whereby to define with said free-board deck a space for technical services.

3. A hospital construction as claimed in claim 1 or 2, wherein said load-bearing structure fors a unitary flex said hull and said bottom comprising sheet metal modules of dimensions corresponding to said beams and welded edge to edge and reinforced by longitudinal and transverse stiffeners, said hull extending above said free-board deck.

4. A hospital construction as claimed in any of claims 1 to 3 wherein said beams comprise transverse members longitudinal carlings forming a grid supported on said pillar said freeboard deck and the floors and decks above comprising a metal floor covered by a layer of reinforced concrete.

5. A hospital construction as claimed in any of claims 1 to 4 wherein said load-bearing structure comprises upper deck, and an intermediate deck between said freeboard deck and said upper deck and defining with said freeboard deck a space within which pass service ducting.

6. A hospital construction as claimed in any of claims 1 to 5, wherein said pillars are tubular and contain ducting for electricity, water supply, water drainage, and present lateral openings for connections at the levels of the superstructure.

7. A hospital construction as claimed in any of claims 1 to 6 wherein said superstructure comprises operating and radiology blocks, consultation and reanimation rooms and bedrooms, said superstructure being topped by a heat insulating terrace.

8. A hospital construction as claimed in claim 7 wherein said bedrooms are disposed along the sides of the superstructure, with an alleyway in the shape of a loop passing outside said bedrooms, and the medico-technical services being disposed in the middle of said superstructure, said bedrooms comprising respective first doors opening onto said and respective second doors opening into the medico-technical services.

9. A hospital construction as claimed in claim 7 or 8 wherein said terrace comprises material for storing solar energy, or solar transducer cells.

10. A method of producing a hospital, comprising producing a construction according to any of claims 1 to 9 at a first site, launching the construction onto water with said load-bearing structure floating to support said superstructure, transporting said construction by water to a second site, and installing said construction on ground at said second site.

11. A method of producing a hospital as claimed in claim 10 wherein the spaces within said double walled hull and double bottom are compartmented, to form caissons which are used for ballasting and level adjustment during transport and as reservoirs when installed at said second site.

12. A method of producing a hospital as claimed in claim 10 or 11 wherein said construction is installed on piles at said second site.

13. A method of producing a hospital as claimed in claim 12 wherein said construction is raised on said piles so as to be unmoved by water swell, said pulses being reinforced by concrete cast on the bottom of the water, and said load-bearing structure being supported on said piles by brackets welded to said hull in line with said lines of pillars.

14. A method of producing a hospital as claimed in claim 10 or 11 wherein said double bottom is grounded at said second site.

15. A method of producing a hospital as claimed in claim 14 wherein said load-bearing

structure forms a foundation disposed in a bed prepared to receive said construction in the shore, said bed being subsequently cut off from the water and filled in with solid material.

16. A method of producing a hospital as claimed in any of claims 10 to 15 wherein said construction is connected with land-based services and buildings at said second site.

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Tiivistelmä

The hospital construction can be floated from its construction site to the site where it is to be used. The hospital construction comprise a load-bearing structure including a double hull (3, 4) and a double bottom (5, 6) forming a rigid water-tight space, acting as a barge during transport and as a foundation when installed at its destination, the load- bearing structure also including a deck comprising a grid of longitudinal and transverse beams, lines of pillars (17) supported on the intersections of said beams from the double bottom, and a freeboard deck (13), said load-bearing structure supporting a superstructure equipped with technical material and installations.

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RAPPORT DE RECHERCHE EUROPEENNE

Numéro de la demande

EP 82 40 2099

DOCUMENTS CONSIDERES COMME PERTINENTS			
Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendication concernée	CLASSEMENT DE LA DEMANDE (Int. Cl. 3)
A	DE-A-2 716 481 (S.POLONYI et al.) *Page 6, lignes 16-20; pages 7,8; figures 1-5*	1	B 63 B 35/44 E 04 H 3/08 E 02 D 29/06
A	FR-A-2 449 764 (ALSTHOM ATLANTIQUE) *Page 2, lignes 29-39; page 3; figures 1-5*	1	
A	FR-A-2 303 140 (MITSUBISHI JUKOGYO KABUSHIKI KAISHA) *Page 2, lignes 25-40; page 3,4; figures 1-6*	1,13	
A	US-A-3 262 411 (L.V.KALTENECKER) *Colonne 2, lignes 40-51; colonne 3, lignes 18-75; colonne 4, lignes 1-52; colonne 5, lignes 11-23; figures 1-4*	1,13	DOMAINES TECHNIQUES RECHERCHES (Int. Cl. 3)
A	GB-A-1 531 629 (A.A.YEE) *Page 2, lignes 42-130; page 3, lignes 1-3; figures 1-4*	1,2	B 63 B E 02 D E 04 H
A	FR-A-1 593 398 (R.BROCARD et al.) *Page 3, lignes 5-20; figures 1,2*	9	

Le présent rapport de recherche a été établi pour toutes les revendications

Lieu de la recherche	Date d'achèvement de la recherche	Examinateur
LA HAYE	17-03-1983	PRUSSEN J.R.

CATEGORIE DES DOCUMENTS CITES

X : particulièrement pertinent à lui seul
Y : particulièrement pertinent en combinaison avec un autre document de la même catégorie
A : arrière-plan technologique
O : divulgation non-écrite
P : document intercalaire

T : théorie ou principe à la base de l'invention
E : document de brevet antérieur, mais publié à la date de dépôt ou après cette date
D : cité dans la demande
L : cité pour d'autres raisons

& : membre de la même famille, document correspondant